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PATENT ABSTRACTS OF JAPAN

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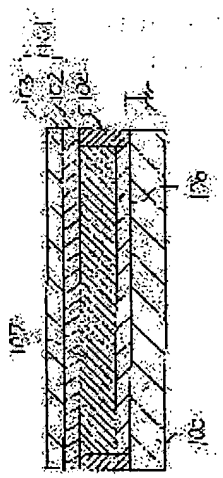
(54) ELECTROPHORESIS DISPLAY DEVICE

(57)Abstract:

PURPOSE: To obtain high display quality and prevent picture quality from deteriorating regardless of repetitive use by setting the surface resistance of a surface where an electrostatic image is formed, between surfaces of the back insulating substrate of an electrophoresis display panel, to a specific value.

CONSTITUTION: The back insulating substrate 101 is constituted by laminating and fixing a polyethylene terephthalate film 102 and a polyethylene terephthalate film 103 which is made conductive and adhered and fixed to a transparent substrate 105 such as a glass plate across spacers 104 so that the film 103 is on the side of the surface where the electrostatic image is formed, thereby forming a sealed space. A transparent electrode 106 is made of ITO, etc., and electrophoresis display liquid 107, obtained by suspending paraffin hydrocarbon as a dispersant, titanium dioxide as white particulates, blue dye, a stabilizer, etc., is charged in the sealed space to constitute the electrophoresis display panel. The surface resistance of the film 103 where the electrostatic image is formed with corona ions is 5×109-5× 1012. An image with a 5.5 contrast is obtained by this device, there is no image blur generated, and even when the device is used repeatedly, the image has neither display irregularity nor erasure defect.



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G 09 F 9/37	311 A	8621－5G	

審査請求　未請求　請求項の数 1　（全5頁）

⑭発明の名称　電気泳動表示装置

⑳特　願　平2－232060
㉒出　願　平2(1990)8月31日

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最終頁に続く

明　細　書

1．発明の名称

電気泳動表示装置

2．特許請求の範囲

1．透明電極が形成された透明基板と背面絶縁基板とをスペーサを介して所要間隔をあけて対向配置して形成される密封空間に電気泳動表示液を充填してなる電気泳動表示パネルと、背面絶縁基板面に選択的にコロナイオンを帯電させ静電像を形成する手段とを備えた電気泳動表示装置において、背面絶縁基板の静電像が形成される面の表面抵抗を$5\times10^{9}\Omega$及至$5\times10^{11}\Omega$としたことを特徴とする電気泳動表示装置。

3．発明の詳細な説明

（産業上の利用分野）

本発明は、電気泳動表示装置に関する。

（従来の技術）

電気泳動表示装置は、電界の印加により表示状態の変化する電気泳動表示液を密封充填した電気泳動表示パネルと、電気泳動表示パネルに電界を印加する手段とから構成されており、これまで種々のものが提案されている。

電気泳動表示液は有機溶媒などの分散媒と、酸化チタンなどの泳動微粒子（以下微粒子という）と、この微粒子と色のコントラストを付けるための分散媒用染料、および分散安定剤、荷電付与剤などの安定化剤などよりなる。また電気泳動表示パネルは、透明電極が形成された透明基板と背面絶縁基板とをスペーサを介して所要間隔をあけて対向配置し密封空間を形成し、この密封空間に電気泳動表示液を充填した構成をしている。この電気泳動表示液に電界を印加することにより、電気泳動表示液の微粒子が透明基板側へ泳動し、表示面には微粒子の色が現れる。逆方向の電界印加により微粒子は背面絶縁基板側へ泳動し、表示面には着色された分散媒の色が現れる。このように電気泳動表示装置は、電界の向きを制御することにより所望の表示を得ることができ、表示にメモリ性も有するので低消費電力化が可能であり、高コントラストの表示が得られる。

電気泳動表示パネルに電界を印加する手段として、特開昭６２－８４１３７号公報に示されるコロナイオンの帯電を用いた装置では、表示を行なおうとする箇所とそうでない箇所とのクロストークの問題が無いため、大面積、大容量の表示が可能となり、大形の電子ディスプレイとして期待されている。

第２図は、この方式の電気泳動表示装置の構成を示すものである。電気泳動表示パネル６は透明電極６ｃの形成された透明基板（表示面）６ｄと背面絶縁基板６ａとがスペーサ６ｂを介して所要間隙をあけて対向配置され密封空間を形成し、この密封空間に電気泳動表示液７が充填されている。電気泳動表示パネルへの電界印加はコロナイオンの帯電による静電像を利用する。その動作を第３図と共に説明する。金メッキタングステン線（コロナワイヤ）１に、正または負の電圧を印加してコロナイオンを発生させる。２は放電フレームである。このイオンは制御回路基板３によって制御回路基板の通過が制御される。制御回路基板３は

上部制御電極３ａと下部制御電極３ｂが所定間隔をあけて配置され、中央に設けられた透孔をコロナイオン流が通過できるように構成されている。第３図（ａ）のように上部制御電極３ａが正、下部制御電極３ｂが負になるように、制御電源８を印加すると電界が順方向となり、コロナイオンが通過し背面絶縁基板６ａ上に静電像４を形成する。逆に第３図（ｂ）のように制御電源８を逆極性に印加するとコロナイオンは通過できない。なお、９はバイアス電源である。制御回路基板を通過して電気泳動表示パネルの背面絶縁基板６ａに帯電している静電像４の消去は逆極性のコロナイオンを用いて行う。すなわち、第３図（ａ）に於てコロナワイヤ１に第３図（ａ）と逆の電圧を印加して負のコロナイオンを発生させ、制御電源８、バイアス電源９に第３図（ａ）と逆の電圧を印加すれば負のコロナイオンが制御回路の透孔を通過し、静電像４（正のコロナイオン）に注し、静電像４が消去される。

第４図は電気泳動表示装置の斜視図であり、駆

動法について説明する。１０はイオンフロー制御部でコロナワイヤ１、放電フレーム２、制御回路基板３より構成されている。制御回路基板３には、一定ピッチ（例えば１ｍｍ）で透孔５′、５′、……が多数開けられ、透孔の周囲には第３図で説明した上部制御電極と下部制御電極が対を成してかつ隣接する電極とは互いに独立して形成されており（図示せず）、この多数の一対の電極群が制御電極列を構成する。イオンフロー制御部１０は上下に一定のピッチ（例えば１ｍｍ）で移動させる（走査）。第４図の場合、制御電極列の方向（水平方向）が行であり、イオンフロー制御部１０の上下移動により生ずる垂直方向の制御電極列が列であり、行と列の交点が画素となる。駆動は、イオンフロー制御部１０を一定のピッチで移動させ（走査）、行と列の交点の画素にコロナイオンを選択的に帯電させて静電像４を形成することにより行う。

第４図において、１１は微粒子、１２は光導である。第４図ではイオンフロー制御部１０を水平

に配し、上下に走査させる方式を示したが、イオンフロー制御部を垂直に配し、左右に走査させる方式も可能である。

（発明が解決しようとする課題）

このような電気泳動表示装置では、背面絶縁基板の静電像が形成される面において、面内方向での急激な電荷の移動が生じると、表示画像のにじみ、ぼけ等の画質劣化の要因となるため、ある程度以上の表面抵抗が必要である。しかし、この場合形成された静電像が残存して表面電位が保持され、繰り返し使用に際しては前画像の履歴が残ることになる。このように表面電位が不均一の状態で画像の消去、更新などを行うと、表示むら、消去不良等の事態が生じる。

本発明は、表示品質が高く、かつ繰り返し使用に際しても画質劣化のない電気泳動表示装置を提供するものである。

（課題を解決するための手段）

繰り返して画像を表示させる場合、前画面の履歴が残らないようにするためには、一回の画像表

（発明の効果）

電気泳動表示パネルの背面絶縁基板の表面のうち、静電像が形成される面の表面抵抗を５×１０^{9}Ω及至５×１０^{11}Ωにすることにより、画質劣化を伴うことなく表面電位を減衰させることができ、繰り返し使用に際しても表示品質を保つことができる。

このように本発明によれば、表示品質が高く、かつ繰り返し使用に際しても画質劣化のない電気泳動表示装置を得ることができる。

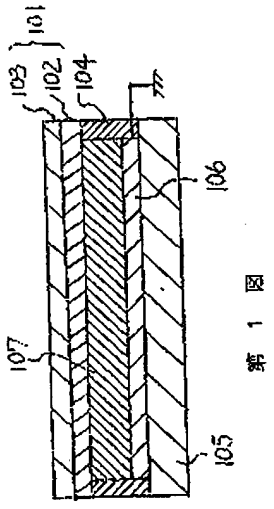
４．図面の簡単な説明

第１図は本発明の電気泳動表示パネルの断面図、第２図は電気泳動表示装置の構成を示す断面図、第３図は静電像の形成を説明する回路図、第４図は電気泳動表示装置の斜視図である。

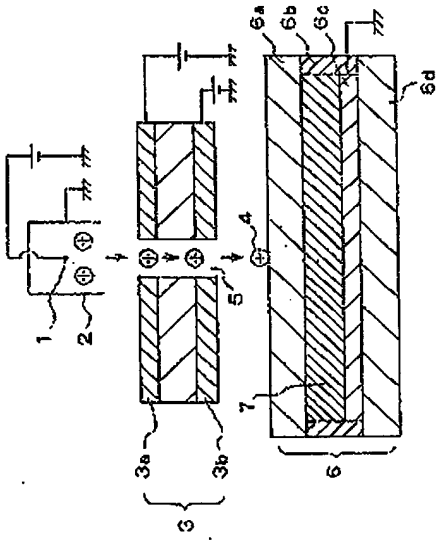
符号の説明

１０１　背面絶縁基板
１０２　ポリエチレンテレフタレートフィルム
１０３　導電処理済ポリエチレンテレフタレートフィルム
１０４　スペーサ
１０５　透明基板
１０６　透明電極
１０７　電気泳動表示液

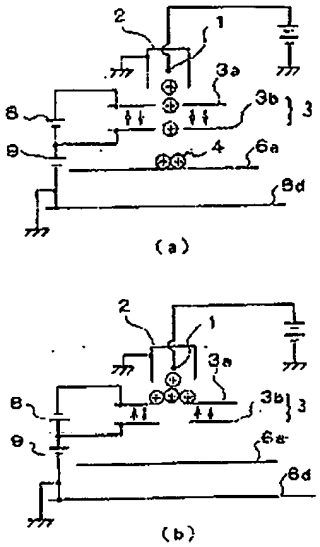
代理人　弁理士　広　瀬



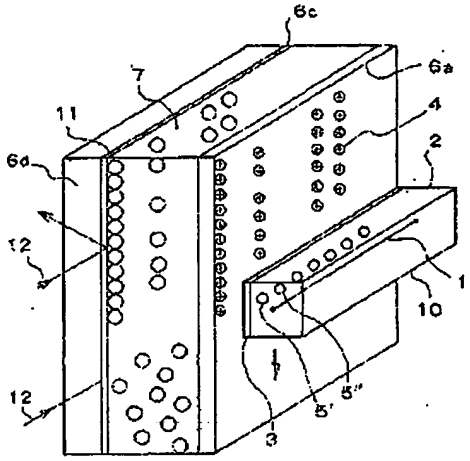
第１図



第２図



第 3 図



第 4 図

第1頁の続き

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(19) Japanese Patent Office (JP) (11) Unexamined Patent Application (Kokai) No.

(12) Unexamined Patent Gazette (A) 4–113386

(51) Int. Cl.[5]	Classification Symbols	Internal Office Registration Nos.	(43) Date of Publication: April 14, 1992
G 09 F 9/37	311 A	8621-5G	

Request for Examination: Not yet submitted | Number of Claims: 1 | Total of 5 pages [in original]

(54) Title of the Invention: **Electrophoretic Display Device**

(21) Application No.: 2–232060
(22) Date of Filing: August 31, 1990
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(Continued on last page)

SPECIFICATION

1. Title of the Invention

Electrophoretic Display Device

2. Claims

1. An electrophoretic display device comprising an electrophoretic display panel in which an electrophoretic display solution is contained in a sealed space formed by a reverse-side insulating substrate and a transparent substrate with a transparent electrode that are disposed facing each at a prescribed interval other across a spacer; and means for selectively charging the surface of the reverse-side insulating substrate with corona ions and forming an electrostatic image, wherein the electrophoretic display device is characterized in that the surface resistance

on the surface of the reverse-side insulating substrate in which the electrostatic image is formed is 5×10^9 Ω to 5×10^{12} Ω.

3. Detailed Description of the Invention

(Field of Industrial Utilization)

The present invention relates to an electrophoretic display device.

(Prior Art)

An electrophoretic display device comprises a sealed electrophoretic display panel filled with an electrophoretic display solution for varying the display state through the application of voltage, and means for applying an electric field to the electrophoretic display panel. Numerous types of these devices have already been proposed.

An electrophoretic display solution comprises an organic solvent or other dispersion medium, titanium oxide or another type of electrophoretic microparticles (referred to hereinbelow as "microparticles"), and dyes for the dispersion medium designed to create a color contrast with the microparticles, as well as dispersion stabilizers, charge-imparting agents, and other stabilizers. The electrophoretic display panel is configured such that a reverse-side insulating substrate and a transparent substrate with a transparent electrode are placed facing each at a prescribed interval other across a spacer to form a sealed space, and the sealed space is filled with the electrophoretic display solution. Applying an electric field to the electrophoretic display solution will cause the microparticles in the electrophoretic display solution to migrate toward the transparent substrate, and the color of the microparticles to appear on the screen. Application of an electric field in the opposite direction will cause the microparticles to migrate toward the reverse-side insulating substrate, and the color of the colored dispersion medium to appear on the screen. The electrophoretic display device thus allows the desired display to be obtained by controlling the direction of the electric field, to reduce power consumption due to the special properties of the display, and to obtain highly contrast displays.

The device with corona ion charging disclosed in JP (Kokai) 62-34187, which was proposed as a means for applying an electric field to an electrophoretic display panel, is free

from the problem whereby crosstalk occurs between display and non-display areas, thereby making it possible to create wide-surface, high-capacity displays and laying the groundwork for designing large electronic displays.

Fig. 2 depicts the structure of such an electrophoretic display device. In the electrophoretic display panel 6, a reverse-side insulating substrate 6a and a transparent substrate (screen) 6d with a transparent electrode 6c are placed facing each other at a prescribed interval across a spacer 6b to form a sealed space, and the sealed space is filled with an electrophoretic display solution 7. An electrostatic image based on the charge carried by corona ions is used to apply an electric field to the electrophoretic display panel. The operation of the device is described with reference to Fig. 3. A positive or negative voltage is applied to a gold-plated tungsten wire (corona wire) 1 to generate corona ions. "2" is a discharge frame. The flow of the ions is controlled with a control circuit substrate 3. The control circuit substrate 3 is configured such that a top control electrode 3a and a bottom control electrode 3b are disposed at a specific interval, and corona ions can pass via the through-hole formed in the center. If a control power source 8 is applied such that the top control electrode 3a is positive and the bottom control electrode 3b is negative, the electric field has the forward direction, the corona ions can flow, and an electrostatic image 4 is formed on the reverse-side insulating substrate 6a, as shown in Fig. 3(a). By contrast, the corona ions cannot flow if the control power source 8 is applied with a reverse polarity, as shown in Fig. 3(b). "9" is a bias power source. The electrostatic image 4 that has passed through the control circuit substrate and created a charge on the reverse-side insulating substrate 6a of the electrophoretic display panel is erased with corona ions of reverse polarity. Specifically, negative corona ions are caused to flow via the through-hole of the control circuit, these ions reach the electrostatic image 4 (positive corona ions), and the electrostatic image 4 is erased by a process in which a voltage that is the reverse of that in Fig. 3(a) is applied to the corona wire 1 in Fig. 3(a), negative corona ions are generated, and a voltage that is the reverse of that in Fig. 3(a) is applied to the bias power source 9.

Fig. 4 is a perspective view of an electrophoretic display device, which will be used to describe the drive technique. 10 is a an ion flow control unit composed of a corona wire 1, discharge frame 2, and control circuit substrate 3. Multiple through-holes 5', 5", ... are formed at a constant pitch (for example, 1 mm) in the control circuit substrate 3, the top and bottom control

electrodes described with reference to Fig. 3 are formed in pairs around the through-holes such that adjacent electrodes (not shown) are separated from each other, and multiple pairs of electrode groups constitute a control electrode sequence. The ion flow control unit 10 can move (scan) up and down at a constant pitch (for example, 1 mm). In Fig. 4, the direction (horizontal direction) of the control electrode sequence constitutes a row, and the control electrode sequence in the perpendicular direction resulting from the vertical movement of the ion flow control unit 10 constitutes a column, and a point of intersection between the row and column constitutes a pixel. The drive is performed by moving (scanning) the ion flow control unit 10 at a constant pitch, selectively charging the pixels at the points of intersection between such rows and columns with corona ions, and forming an electrostatic image 4.

In Fig. 4, "11" is a microparticle, and "12" is a ray of light. Fig. 4 shows an arrangement in which the ion flow control unit 10 is disposed horizontally and is scanned vertically, but it is also possible to adopt an arrangement in which the ion flow control unit is disposed vertically and is scanned from left to right.

(Problems to Be Solved by the Invention)

Such an electrophoretic display device requires a certain minimum surface resistance because a surface image becomes blurry, hazy, or otherwise degraded in terms of image quality as a result an abrupt movement of electric charges along an in-plane direction of the surface in which an electrostatic image is formed on the reverse-side insulating substrate. The electrostatic image formed in this case is allowed to linger, the surface potential is preserved, and the history of previous images stays on during repeated use. Display irregularities, erasure defects, and other problems are encountered if the image is erased, refreshed, or otherwise manipulated in a state in which the surface potential remains nonuniform in this manner.

An object of the present invention is to provide an electrophoretic display device that has high display quality and is free from image degradation even during repeated use.

(Means Used to Solve the Above-Mentioned Problems)

To prevent the history of previous images from staying on when the images are repeatedly displayed, it is necessary to allow the potential that results from charging the surface of the insulating substrate surface to have sufficient time to decay with every new image display, and to display the next image from a uniform state. But the decay must be performed smoothly because an abrupt decay will cause an image to become blurry or the like, as described above.

The present invention was perfected upon the discovery that adjusting the surface resistance of the insulating substrate to an optimum level is effective for causing the potential on the surface of the insulating substrate to decay without the accompanying degradation in image quality.

The present invention is characterized in that the surface resistance on the surface of the reverse-side insulating substrate in which an electrostatic image is formed is brought to $5 \times 10^9\ \Omega$ to $5 \times 10^{12}\ \Omega$.

Blurring will occur if the surface resistance on the surface of the reverse-side insulating substrate in which an electrostatic image is formed is less than $5 \times 10^9\ \Omega$, and the potential decay will be slow if the resistance exceeds $5 \times 10^{12}\ \Omega$, causing erasure defects and display irregularities to appear during the second and subsequent cycles.

Fig. 1 depicts an electrophoretic display panel obtained using an insulating substrate whose surface resistance has been adjusted in accordance with the present invention. The reverse-side insulating substrate 101 is formed by laminating and fixing a polyethylene terephthalate film (thickness: 100 μm) 102 and a polyethylene terephthalate film (Lumirror 50X53, registered trade name, manufactured by Toray, thickness: 100 μm) 103 that has been rendered electrically conductive; the components are bonded and fixed to a glass plate (thickness: 3 mm) or other transparent substrate 105 via a spacer 104 with a thickness of 0.1 mm such that the polyethylene terephthalate film 103 that has been rendered electrically conductive forms a surface on which electrostatic images can be formed with corona ions; and a sealed space is formed. "106" is ITO (indium tin oxide) or another transparent electrode. The sealed space is filled with a electrophoretic display solution 107 obtained by suspending a paraffin-

based hydrocarbon (Isopar G, registered trade name, manufactured by Exxon Chemical) as the dispersion medium, titanium dioxide (R3L-SN, registered trade name, manufactured by Sakai Chemical) as white microparticles, a blue dye (Macrolex Blue RR, registered trade name, manufactured by Bayer), a stabilizer, and the like; and an electrophoretic display panel is thus obtained. The surface (polyethylene terephthalate film (Lumirror 50X53, registered trade name) 103 that has been rendered electrically conductive) of the insulating substrate 101 in which an electrostatic image is formed by means of corona ions has a surface resistance of 10^{11} Ω. The display and the decay waveform of the potential on the insulating substrate surface in the electrophoretic display device were measured, and it was found that an image with a contrast of 5.5 had been obtained and that the image did not undergo any blurring or the like. The potential was about 1200 V immediately after the write operation, decayed as a waveform with a time constant of about 40 sec, and did not cause any image display blurring, erasure defects, or the like when one image was erased and the subsequent image was written at a uniform potential during repeated use.

Contrast is defined as the ratio of the brightness observed when the color of microparticles appears on the screen in relation to the brightness observed when the color of the colored dispersion medium appears on the screen.

When a polyethylene terephthalate film (surface resistance: 10^{17} Ω) alone was used as the insulating substrate, an adequate image was obtained in the initial image display, but the potential on the surface of the insulating substrate decayed only minimally, the previous image could not be erased satisfactorily, the display results were nonuniform, and the display quality was markedly degraded in the second and subsequent cycles.

(Embodiments, Comparative Examples)

In the electrophoretic display panel shown in Fig. 1, a polyethylene terephthalate film alone was used as the reverse-side insulating substrate, the substrate surface was treated with an antistatic agent (190S, registered trade name, manufactured by Soken), the surface resistance was brought to 10^{8} Ω, 10^{10} Ω, 10^{12} Ω, or, 10^{14} Ω, and electrophoretic display devices were obtained.

In the devices with 10^{10} Ω and 10^{12} Ω, the time constants for the potential decay were about 27 sec and about 45 sec, respectively, the images were not blurred, and a display with a contrast of 5 was obtained. Repeated use did not produce any remaining history of the preceding images, and an adequate image display could be sustained.

In the device with 10^{8} Ω, the time constant for the potential decay was about 6 sec, the image was blurred, and the entire screen became hazy because the electric charge was moving abruptly along an in-plane direction on the insulating substrate.

In the device with 10^{14} Ω, the time constant for the potential decay was about 120 sec and the initial image display was adequate, but erasure defects, display nonuniformities, and the like occurred during the second and subsequent cycles.

(Effect of the Invention)

Setting the surface resistance of that portion of the surface of the reverse-side insulating substrate for an electrophoretic display panel on which an electrostatic image is formed to 5×10^{9} Ω to 5×10^{12} Ω makes it possible to cause the surface potential to decay without the accompanying degradation in image quality, and to maintain the desired display quality during repeated use.

This, the present invention can provide an electrophoretic display device that has high display quality and is free from any image quality degradation during repeated use.

4. Brief Description of the Drawings

Fig. 1 is a cross section of the electrophoretic display panel of the present invention; Fig. 2 is a cross section depicting the structure of the electrophoretic display device; Fig. 3 is a circuit diagram illustrating the shape of an electrostatic image; and Fig. 4 is a perspective view of the electrophoretic display device.

101: reverse-side insulating substrate

102: polyethylene terephthalate film

103: polyethylene terephthalate film that has been rendered electrically conductive

104: spacer

105: transparent substrate

106: transparent electrode

107: electrophoretic display solution

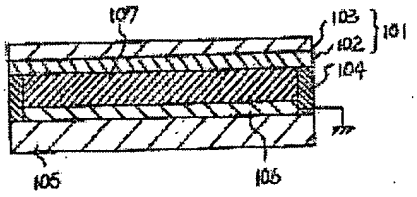

Fig. 1

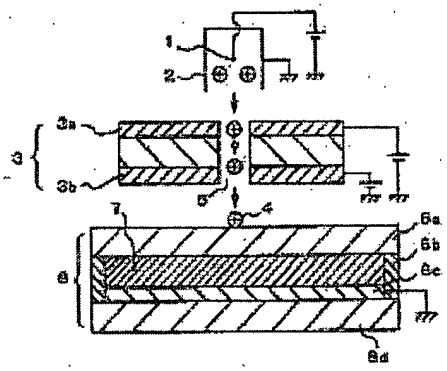

Fig. 2

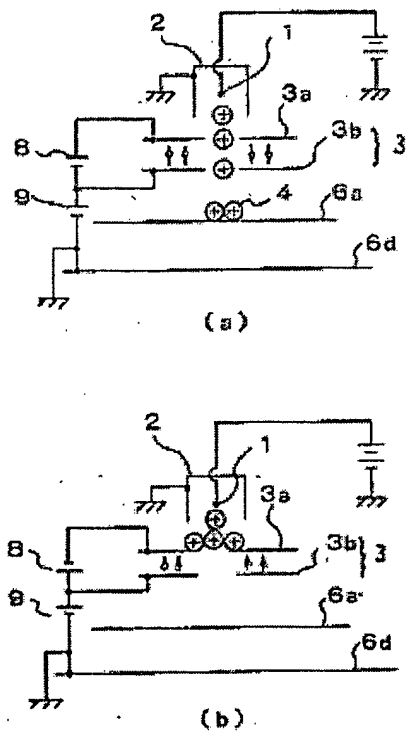

Fig. 3

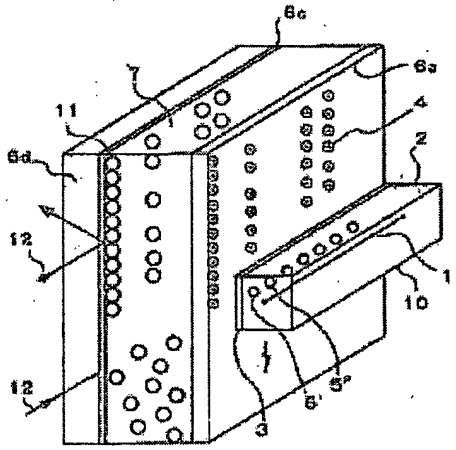

Fig. 4

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